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New records of the exotic Band-eyed Drone Fly, *Eristalinus taeniops* (Wiedemann, 1818) (Diptera, Syrphidae), in Argentina

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Abstract

Eristalinus (*Eristalodes*) *taeniops* (Wiedemann, 1818) is a pollinator hoverfly native to the Old World that has spread through several countries in America. We determine the current distribution of this species in Argentina by using records from scientific literature and citizen science websites. In addition, we report the first three specimens collected in Córdoba province. *Eristalinus taeniops* is present in 10 provinces in Argentina and seems to be more frequent in anthropized habitats. Likewise, the specimens we collected were exclusively captured within the city of Córdoba. Our results confirm the occurrence of *E. taeniops* in central Argentina and contribute to determining the actual geographic distribution of this species in the country. Our new data could help to evaluate the potential invasiveness of *E. taeniops* in ecosystems.

Keywords

Citizen science, Córdoba city, exotic pollinator, flower fly, geographical distribution, hoverfly

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Introduction

Hoverflies or flower flies (Diptera, Syrphidae) are one of the most diverse and widespread groups of insects, comprising more than 200 genera and over 6,000 described species worldwide (Pape and Thompson 2019). Adults of many hoverflies species are important pollinators in both natural and agricultural crop systems (Valladares et al. 2019). Larval feeding habits include decomposers of organic matter, featuring both mycophagous and phytophagous habits, as well as parasitoids and predators with a well-known role as biological control agents of agricultural pests (Pineda and Marcos-García 2008; Fidelis et al. 2018; López-García et al. 2019). Four subfamilies are included within Syrphidae: Microdontinae, Syrphinae, Pipizinae, and Eristalinae (Smit et al. 2017; Sonet et al. 2019). Eristalinae includes the genus *Eristalinus* Rondani, 1845 (tribe Eristalini, subtribe Eristalina), which comprises five subgenera—*Eristalinus* (including *Lathyrophthalmus* Mik, 1897), *Eristalodes* Mik, 1897, *Helophilina* Becker, 1923, *Merodonoides* Curran, 1931, and *Oreristalis* Séguy, 1951—with 81 species naturally occurring in Palearctic and Afrotropical regions (Thompson 2003; Sonet et al. 2019). Most *Eristalinus* species mimic bees and are large hoverflies (4–16 mm), occupying a wide variety of habitats including

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open grasslands, shrublands, river valleys, forest margins, wetlands, lakeshores, and even urban areas (Sonet et al. 2019).

Eristalinus (*Eristalodes*) *taeniops* (Wiedemann, 1818), known as Band-eyed Drone Fly (Fig. 1A–C), is an efficient pollinator within its original geographic distribution area, which encompasses a large number of countries of the Old World, from Europe and Africa to Asia (Irshad 2014; Speight 2014; Sonet et al. 2019). Adults of *E. taeniops* show an active and generalist behavior when looking for pollen and nectar (Pradhan and Devy 2019), while the immature stages, known as long-tailed or rat-tailed maggots, are filter-feeding larvae inhabiting small temporary water bodies with decaying plant matter or sewage from farms and factories (Pérez-Bañón 2003; Hurtado 2013; Dutto and Maistrello 2017). Moreover, the larvae have also been mentioned as a causative agent of human enteric myiasis (Dutto and Maistrello 2017; Pérez-Bañón et al. 2020).

In the New World, *E. taeniops* was first recorded in the United States in Florida (Thompson et al. 1990), and a few years later Thompson (1999) recorded it at two localities in Chile. The species was subsequently found in several localities in Brazil (Morales and Köhler 2006, 2008; Martins et al. 2013). In Argentina, this hoverfly was recorded for the first time from data obtained between 2000 to 2002 in the Punta Lara Natural Reserve (Ensenada, Buenos Aires province) and the surroundings of the Faculty of Agronomy (National University of Buenos Aires) in Buenos Aires city (Montaldo et al. 2017). Later, the species was reported by Basilio et al. (2009) and Torretta et al. (2010) in Magdalena (Buenos Aires

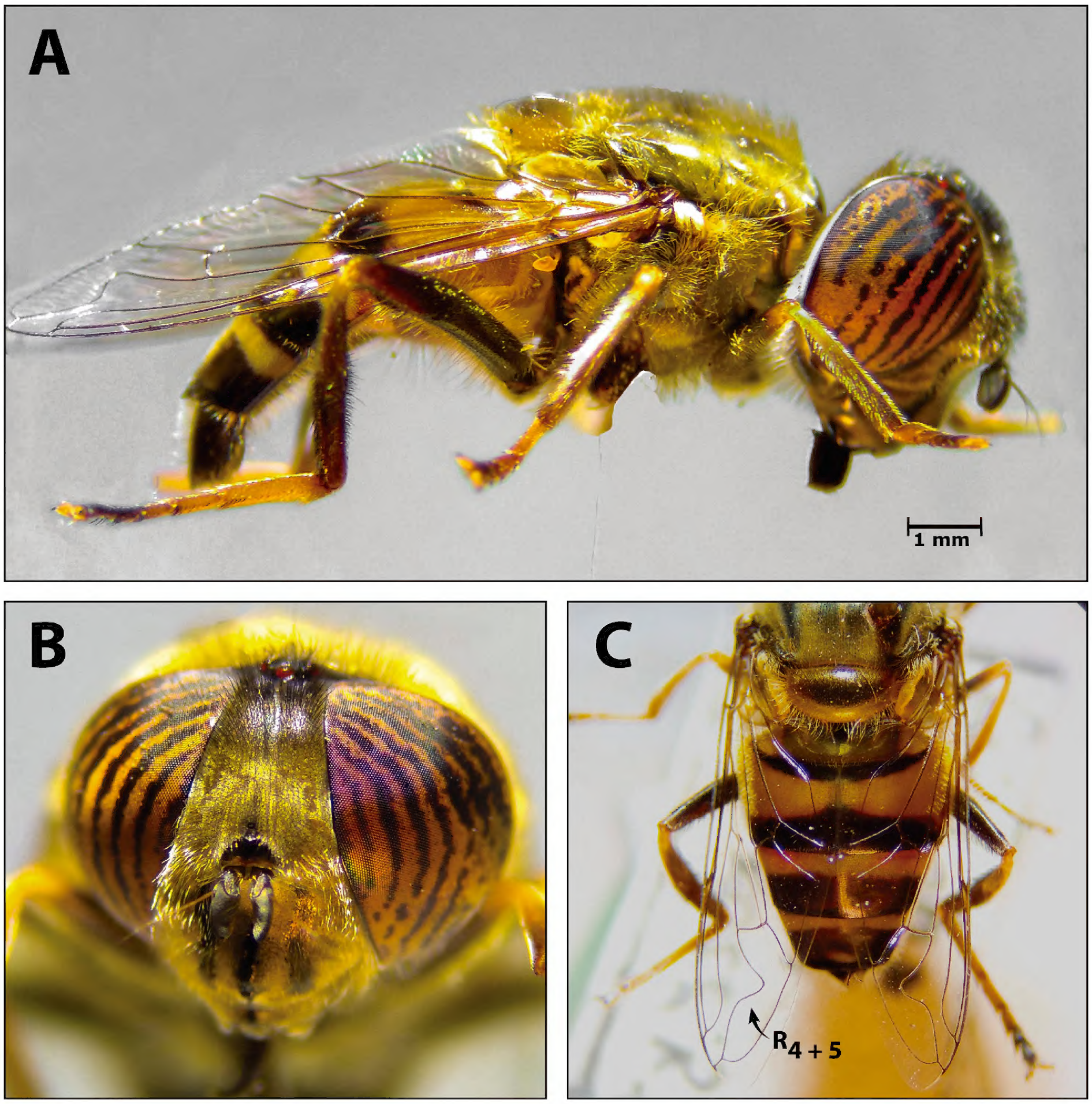

Figure 1. Specimen of *Eristalinus* (*Eristalodes*) *taeniops* (Wiedemann, 1818) found in the home garden indexed (ENTOCOR 1347). **A.** right lateral view. **B.** head detail. **C.** back and wing detail.

province) and Reconquista (Santa Fe province). Recently, the species was found in the Northern Riverside Ecological Reserve, Buenos Aires (Sirolli et al. 2018). Also, several photographic records have been uploaded to citizen science websites (http://www.inaturalist.org/home and http://www.ecoregistros.org), recording *E. taeniops* in many Latin American countries (Paraguay, Uruguay, Bolivia, Brazil, Chile, Peru, Colombia, Ecuador, Costa Rica, and Mexico) and other localities in Argentina.

Knowing the geographic distribution of insect species, such as *E. taeniops*, outside their original range is important to biodiversity conservation given the potential of some species to become invasive and threats to ecological interactions and ecosystem functioning (Kiritani and Yamamura 2003). On the other hand, data on the expansion of exotic species into new areas outside of their native range are extremely valuable for developing distribution models, which are popularly used to predict the potential distributions of species modeled as a function of environmental variables (Fraser et al. 2015). Citizen science records have proved in several recent studies to be a valuable source of occurrence data on some species (Prudic et al. 2018; Vendetti et al. 2018; Hiller and Haelewaters 2019; Werenkraut et al. 2020). However, scientific publications by specialists are still a more reliable source of occurrence data for species in a given locality and often provide additional bio-ecological information (sex, size, etc.) of individuals (Vásquez-Restrepo and Lapwong 2018).

Eristalinus taeniops was probably introduced accidentally in Argentina and has been previously recorded visiting flowers of both native and exotic plants (Basilio et al. 2009; Torretta et al. 2010; Montaldo et al. 2017; Sirolli et al. 2018). However, its potential invasiveness and harms to native organisms are still unknown. In addition, as this syrphid is considered a causative agent of human enteric myiasis, it knowledge of its spread in Argentina could be important for public health. In this work we report the first three specimens collected in Córdoba city, confirming the presence of *E. taeniops* in Córdoba province, central Argentina. Additionally, we determine the current distribution of *E. taeniops* in the country by using citizen science websites and scientific literature records.

Methods

The city of Córdoba, with an area 576 km^2 and a population of 1,330,023, is the second-largest city in Argentina (INDEC 2010). The city has a temperate climate with mean annual precipitation of 800 mm. The winter is markedly dry, and most precipitation occurs in the summer months (Estallo et al. 2018). Suburban areas are characterized by residential neighborhoods, primarily single-family homes with yards, interspersed with 9.27 km^2 of parks and other green spaces (Estallo et al. 2018). Within these urban areas, we captured one specimen of *Eristalinus taeniops* perched on *Euryops pectinatus* (L.) Cass. (Asteraceae). We used an insect vacuum adapted from a vacuum cleaner (Black and Decker model AV1500LA). The sampling was done as part of a project intended to assess the relationship between floral species diversity and their pollinators in home gardens along an urbanization gradient. Two other specimens were collected using yellow pan traps placed in native plants of experimental green roofs built to evaluate the effect of the origin of vegetation (native/exotic) on arthropod diversity. All specimens were deposited in the entomological collection ENTOCOR (IMBIV- Conicet, National University of Córdoba) under the serial numbers 1347, 2339, and 2340.

Records from the available scientific literature and two citizen science websites, iNaturalist.org (http://www.inaturalist.org) and Ecoregistros (http://www.ecoregistros.org), were compiled and mapped using QGIS version 3.14 (QGIS 2020) to show the current distribution of the species in Argentina.

The new records in this paper are deposited at the Global Biodiversity Information Facility (GBIF) and are available at https://doi.org/10.15468/uzw2dv (Rossi and Rotondi 2020).

Results

Eristalinus (*Eristalodes*) *taeniops* (Wiedemann, 1818)

New records. ARGENTINA. • 1 ♀; 12.68 mm; Córdoba City, Córdoba province, home garden; 31°21′25″S, 064°14′55″W; 450 m a.s.l.; 3 April 2019; Bruno Ariel Rossi Rotondi leg.; ENTOCOR 1347. • 1 ♂; 13.70 mm; Córdoba City, Córdoba province, house; 31°22′47″S, 064°14′04″W; 430 m a.s.l.; 21 March 2019; Hernán Mario Beccacece leg.; ENTOCOR 2339. • 1 ♂; 13.13 mm; Córdoba City, Córdoba province, house; 31°22′47″S, 064°14′04″W; 430 m a.s.l.; 21 March 2019; Hernán Mario Beccacece leg.; ENTOCOR 2340.

Identification. The species was identified following the taxonomic keys provided by Miranda et al. (2013) and Smit et al. (2017). *Eristalinus* Rondani, 1845 is a widespread genus, with generalist pollinators and imperfect mimics of bees with punctate (spotted) and/or fasciate (striped) eyes (Sonet et al. 2019). *Eristalinus taeniops* (Fig. 1) is easily distinguished from all other New World eristalines (wings characterized by a sinuate R_{4+5} vein) because it presents a dull, yellowish-gray thorax, with four indistinct black stripes; abdominal segment with three predominantly bright yellow maculae (Miranda et al. 2013; Smit et al. 2017). Additionally, this species presents five or more vertical stripes on the eyes, as opposed to *Eristalinus* (*Eristalodes*) *quinquelineatus* (Fabricius, 1781) which has four vertical bands (Thompson 2003; Smit et al. 2017). Body size measurements were taken with digital calipers.

Distribution. In the scientific literature we found five records of *E. taeniops* in Argentina (Basilio et al. 2009; Torretta et al. 2010; Montaldo et al. 2017; Sirolli et al. 2018), and on citizen science websites, there were 188

records, which together cover data from the beginning of the 21st century to date. The species was found in various ecoregions of the country, both in anthropized and natural environments, and in eleven provinces, with the province of Buenos Aires having the most records. The northernmost record is in Salta province, while the southernmost is in Rio Negro province (Fig. 2).

Discussion

Our search showed that *Eristalinus taeniops* was previously recorded in 11 provinces of Argentina. Most of the records are from the center-east part of the country, particularly from Buenos Aires. The current distribution of this species is evidence of its capacity for expansion in Argentina across different latitudes (33°01′34.92″S to 36°43′56.57″S) and longitudes (065°29′12.56″W to 065° 21′17.65″W) and altitudes (0–1244 m a.s.l.). As Argentina is a very large country with many different biogeographic and climatic zones, our data suggest that this species might be plastic in its response to different habitat conditions, as it occurs with other exotic insect species (Kiritani and Yamamura 2003). Of note is that most records were from citizen science websites, and for this reason, the information in these records should be confirmed with more finds and collected specimens. We present here the first three specimens of the *E. taeniops* collected in Córdoba, confirming its presence in the second largest city of the country.

From our distribution map, we infer that *E. taeniops* is capable of inhabiting both natural and anthropized environments. However, *E. taeniops* seems to be more commonly found in anthropized environments according to the scientific literature on this species in Argentina (Basilio et al. 2009; Torretta et al. 2010; Montaldo et al. 2017; Sirolli et al. 2018) and the prevalent number of urban sites recorded in citizen science websites. Likewise, the three specimens we found in Córdoba were also

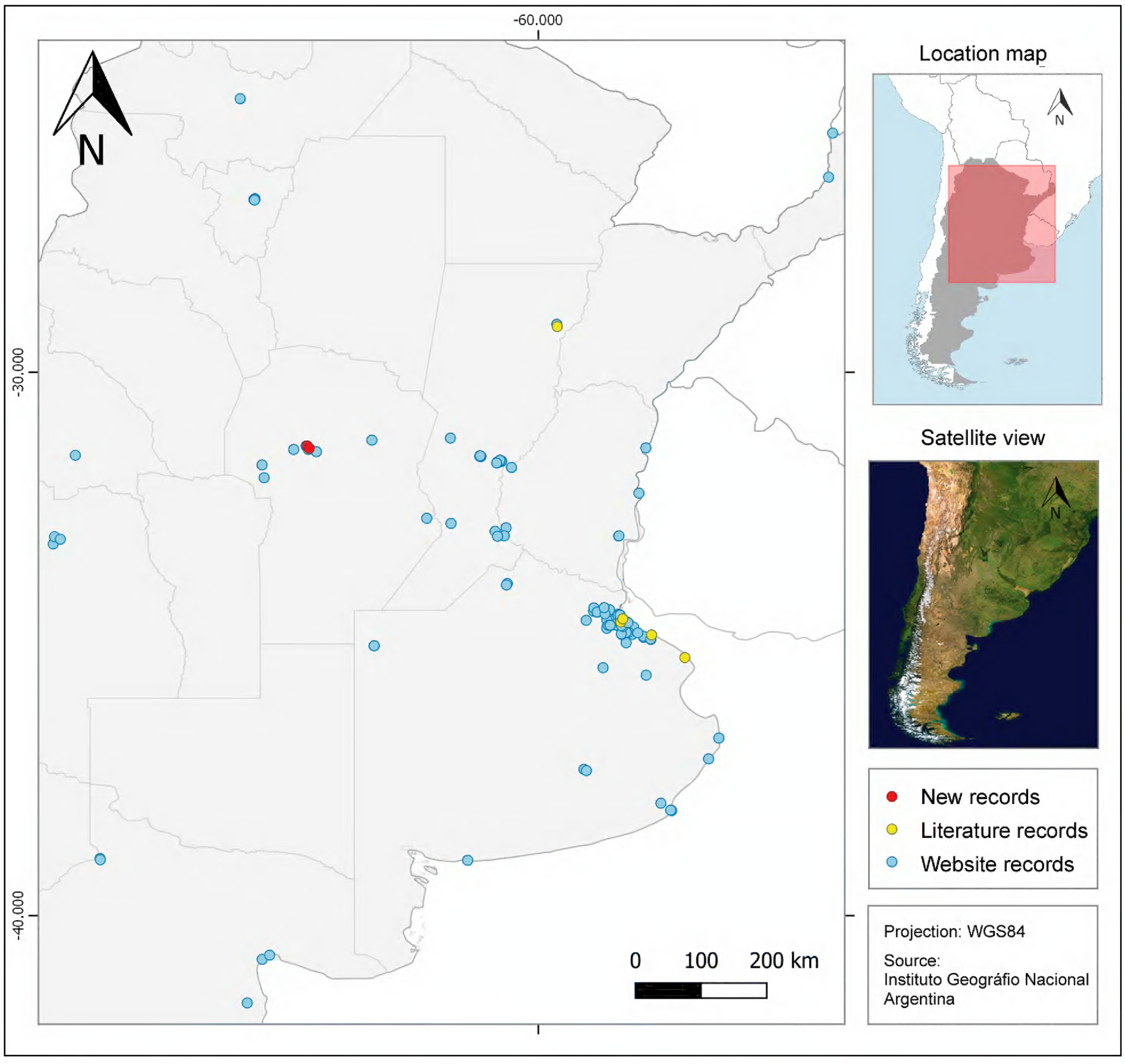

Figure 2. Distribution map of *Eristalinus* (*Eristalodes*) *taeniops* (Wiedemann, 1818) in Argentina. Red circles: new records of specimens collected in Córdoba city; orange circles: records from scientific literature; blue circles: records from citizen science websites.

collected exclusively within the city even though we have carried out several years of sampling campaigns in agroecosystems quantifying pollinators and other insects. It has been proposed that urbanization promotes the occurrence of non-indigenous species, favoring their abundance and diversity, as cities offer unique opportunities for them to thrive (e.g. reduced competition) (Cadotte et al. 2017). Thus, *E. taeniops* might be favored by urbanization, but additional sampling in natural areas are necessary to corroborate this idea. We cannot dismiss that fact that citizen science records are biased towards urban areas, as there are more people in cities with easy access to technology which allows them to upload these data.

Invasive species are one of the main drivers of anthropogenic global change causing biodiversity loss and alteration of ecosystem services, such as pollination, which has significant economic value (IPBES 2019). Invasive pollinators may compete with native pollinators for floral resources, may pollinate exotic flora, or lead to an inadequate pollination of native flora (Kenis et al. 2009; Montaldo et al. 2017). Although *E. taeniops* is a generalist species, its impact on ecosystems should be studied considering previous evidence which shows that even generalized pollinator networks in Syrphidae can provide efficient pollination to plant species (Lucas et al. 2018). In fact, *E. taeniops* has been observed visiting flowers of *Ligustrum lucidum* W.T.Aiton (Oleaceae) in Buenos Aires, a highly invasive woody species in several regions of Argentina (Malizia et al. 2017; Whitworth-Hulse et al. 2020); sunflowers, *Helianthus annuus* L., which is one of the main crops in the country (Torretta et. al 2010); and we even found it visiting Grey-leaved Euryops, *Euryops pectinatus* (L.) Cass., a common ornamental plant. Among native plants, there is a photographic record (Basilio et al. 2009) of *E. taeniops* visiting *Baccharis glutinosa* Pers. in Buenos Aires, a plant also found in Córdoba province, including in urban and suburban areas (Giuliano and Plos 2014). Thus, considering these known interactions of this hover fly with various plant species, additional studies are necessary to quantify the real impact of *E. taeniops* in different ecosystems of the country and to define its potential invasiveness status, which means if the species could become invasive in the near future.

In conclusion, we confirm the presence of the exotic *E. taeniops* in Córdoba city. Thanks to citizen scientists, the photographs with geopositions that are available in public websites are an important tool in determining the current extent of exotic and invasive species. However, it is still necessary to corroborate information with experts and have collected specimens for confirmation. We encourage researchers to undertake more studies of invasive pollinators, beyond Hymenoptera, the group most commonly investigated (Morales et al. 2017).

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Authors' Contributions

BARR, HMB, and MV devised study; BARR collected the insects and searched for website records; BARR identified the species with guidance from HMB. BARR, MV, and MSF wrote the manuscript, and all authors agreed on the final version.

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